PHILOSOPHICAL TRANSACTIONS.

I. *Deſcription of an Improvement in the Application of the* Quadrant of Altitude *to a celeſtial Globe, for the Reſolution of Problems dependant on* Azimuth and Altitude. *By Mr.* John Smeaton, *F. R. S.*; *communicated by Mr.* William Wales, *F. R. S.*

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PERHAPS there are few inſtruments that better fulfil their deſign in general, or more naturally repreſent the movements they are intended to explain and illuſtrate, than the terreſtrial and celeſtial globe, which are alſo applied to reſolve ſome of the problems of the ſphere, which they moſt readily do. I believe, however, that whoever applies to

them for the laſt mentioned purpoſe, will find them more defective in ſome reſpects than they are in others.

The difficulty that has occurred in fixing a ſemicircle, ſo as to have a center in the *zenith* and *nadir* points of the globe, at the ſame time that the meridian is left at liberty to raiſe the pole to its deſired elevation, I ſuppoſe, has induced the globe-makers to be contented with the *ſtrip* of thin flexible braſs, called the *quadrant of altitude*; and it is well known how imperfectly it performs its office.

The improvement I have attempted, is in the application of a *quadrant of altitude*, of a more ſolid conſtruction; which being affixed to a braſs ſocket of ſome length, and this ground, and made to turn upon an upright ſteel ſpindle, fixed in the zenith, ſteadily directs the *quadrant*, or rather *arc*, of *altitude* to its true *azimuth*, without being at liberty to deviate from a vertical circle to the right hand or left: by which means the azimuth and altitude are given with the ſame exactneſs as the meaſure of any other of the great circles.

With reſpect to the horary circle, as the common application ſeems very convenient on account of the ready adjuſtment of its index to anſwer the culmination of any of the heavenly bodies; and as I find that a circle of four inches diameter is capable of an actual and very diſtinguiſhable diviſion into 720 parts, anſwerable to two minutes of time each, which may ſerve a globe of the largeſt ſize; it ſeems that it ſhould rather be *improved* than omitted; and, if inſtead of a *pointer*, an index *ſtroke* is uſed in the ſame plane with that of the diviſions, the ſingle minutes, and even half minutes, may be readily diſtinguiſhed.

This globe, though mounted merely as a model for experiment, and only nine inches in diameter, appears capable of bringing out the ſolution to a quarter of a degree; which, I appre-

apprehend, may be eſteemed ſufficient not only as a check upon numerical computation, but to come near enough to find ſtars in the day-time in the field of teleſcopes, which, having no equatorial motion, are only capable of direction in altitude and azimuth; but from globes of a larger ſize, we may expect to come proportionably nearer.

Explanation of the figures, Plate I.

The figures 1. and 2. being different views of the ſame things, AB repreſents a line, in common to both, in the ſurface of the horizon, which here is of braſs.

CD, CD, are vertical lines, ſuppoſed to paſs through the center of the globe in each figure; and

EFG, EFG, are portions of great circles of the globe.

Fig. 1. ſuppoſes the ſpectator looking at the apparatus of the globe from the ſouth point of the horizon; therefore the circular arch EFG, in this poſition, will be a part of the *prime vertical*, and the ſmall paralellogram HI is ſuppoſed to be a *ſection* of the braſs meridian, according to that vertical plane.

Fig. 2. is a view of the ſame parts, the ſpectator being ſuppoſed to look at them from the weſt point of the horizon; and in this poſition HI is ſuppoſed to be a *portion* of the *braſs meridian*. This being fixed in mind, in what follows the ſame letters denote the ſame parts in both figures.—KLM denotes a piece of braſs, or braſs carriage, made to fit upon the vertical part of the meridian, and capable of ſliding 5° on each ſide of that point, ſo as to adjuſt to it, and to fix faſt there, by means of the finger ſcrew N *. This piece of braſs carries

* The holes repreſented in the portion of the braſs meridian (HI, fig. 2.) are ſcrew holes at five degrees diſtance, in this quarter of the circle, into any of which the finger ſcrew N is to be put as occaſion may require; the *ſlit* allowing ſufficiently for adjuſtment.

the *ſteel ſpindle* PQ, which is firmly ſocketed into it at K, according to the dotted lines *o r*, *o r*. The axis of this ſpindle is therefore capable of being ſet upright upon the *zenith point*, and to maintain that poſition with a ſufficient degree of firmneſs.—R*q*, R*q*, repreſents the ſection of a braſs ſocket made to fit the ſpindle, and turn round freely upon it; and when home to the ſhoulder at *o o*, to turn without ſhake; the ſocket and ſpindle being a ſmall matter taper, and *ground* together. On one ſide of the ſocket is firmly fixed the arm ST, by ſcrews or ſolder.—UW is an arch of 80 degrees, ſerving inſtead of the quadrant of altitude, and of the ſame *ſubſtance* as the meridian. This is firmly ſcrewed to the arm, and adjuſted by conſtruction, ſo that when the *ſpindle* is vertical, the face of this arch ſhall make part of a vertical circle.—This arch being a portion of a circle, of the ſame diameter as the braſs meridian, when its point *zero* at W reſts upon the braſs horizon, its inſide ſurface is made to agree with that of the horizon by means of a ſmall thin *nib* of braſs; that being attached to the inſide of the bottom of the quadrant of altitude at W, and projecting a little below it, gently bears againſt the inſide of the horizon, in ſubſtance occupying about half the *clearance* between the body of the globe and its ſurrounding horizon: this *nib*, ſeen edgeways, is ſhewn at the letter X. By this means the altitude of the object is ſhewn upon the working face of the quadrant, and the quadrant's bottom ſhews the azimuth upon the horizon; at the ſame time the globe is free to revolve upon its axis, clear of all the circles.

The quadrant might be made complete to 90°; but as in theſe middle latitudes there is very little buſineſs for azimuths when the altitudes are above 80°, and as I judged it eligible, that the quadrant ſhould be made capable of working on both ſides the meridian; *that* would be prevented by the neceſſary

thickneſs that the circles require to give them ſolidity, in contradiſtinction to *mathematical planes*; unleſs a part of a quadrant was cut out next the vertex to give them clearance: by this means the arch being lifted up from the ſpindle, and put on the other ſide of the braſs meridian for the afternoon, it will then come within 10° or 15° of the meridian; and if the uſe of this ſpace ſhould be wanted, it can be ſupplied by reverſing the ſimilar operation for the morning; and the back ſide of the upper end of the quadrant at U being champered, or *bevilled* off, this will admit it to come as near to the meridian as I have mentioned.

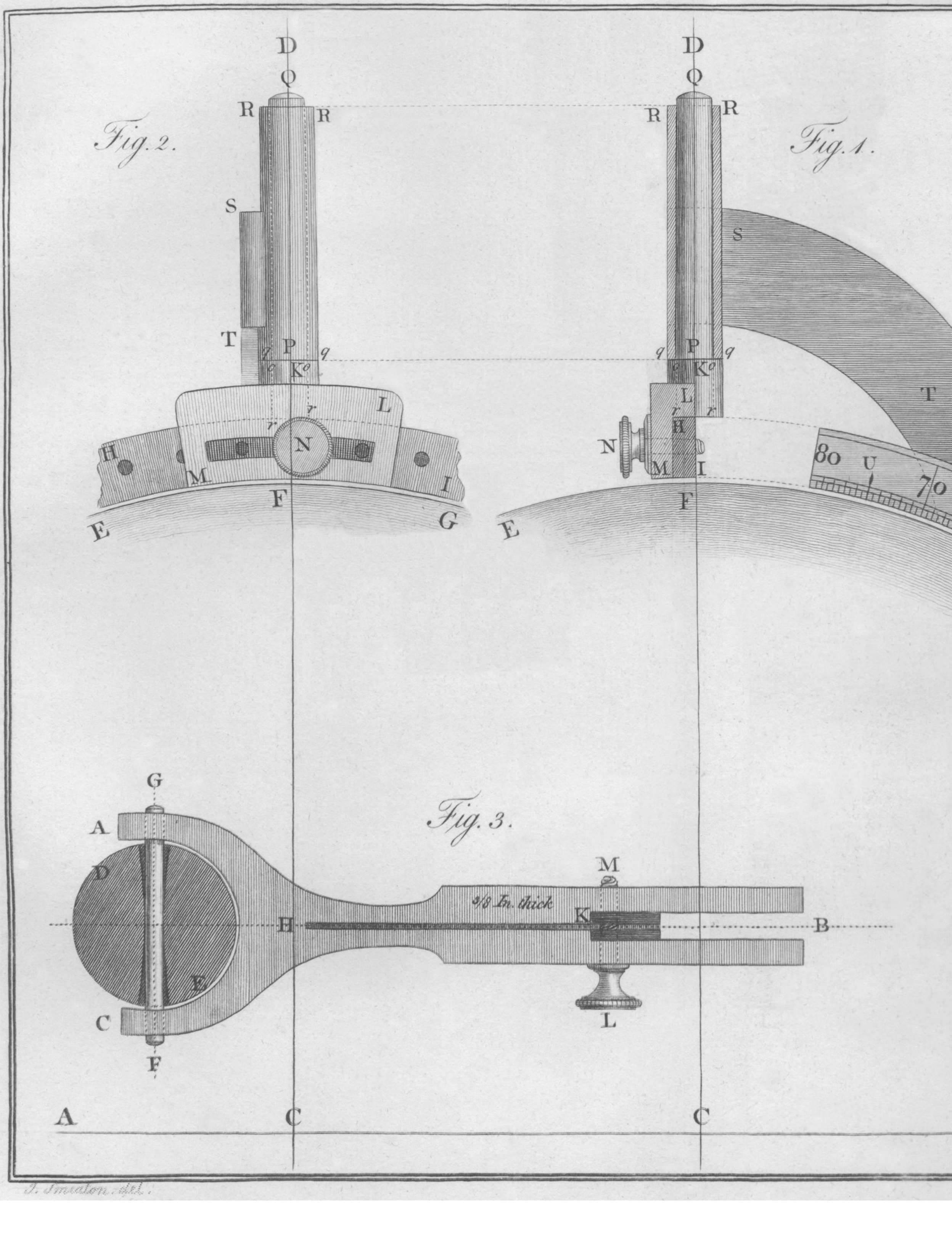
The ſteel ſpindle is eaſily adjuſted to the *zenith*; for the globe being rectified to its *latitude*, ſet the braſs carriage at liberty, bring the quadrant and meridian together, face to face, and ſlide the carriage, till the lower extremity of the quadrant *buts* upon the horizon, and there ſcrew it faſt.

It is, however, to be noted, that I have found ſomething neceſſary by way of *holdfaſt*, to prevent the braſs meridian from ſhifting its latitude, and that without confining it in any other reſpect.—What I have found to anſwer this purpoſe is repreſented, fig. 3. The crutch-like piece of wood ABC is ſhewn as ſeen looking right down upon it. The circle DE is the horizontal ſection of the ſouth pillar of the globe. The ſtrong wire pin FG, that goes through the two arms of the crutch and pillar, ſerves as an axis upon which its other extremity at B is at free liberty to lift up and down, but without ſhake upon the pin; and the whole being ſplit with a fine ſaw, from B to H, the notch BK lays hold of the under ſide of the braſs meridian, and by tightening the finger ſcrew LM, it firmly clips it, and retains it in any given poſition. And that it may be under no confinement *croſs-ways*, the hole in the pillar is opened on both ſides,

as

as ſhewn in the ſection, to give it liberty of accommodation; the pin being faſt in the two ends of the crutch, and turning gently in the pillar; the whole being ſlender and compliant, except in point of length.

N. B. Thoſe that would uſe the globe to the beſt advantage to ſolve problems, ſhould be careful to get a *juſt* declination, as alſo a *diſtinct* point to mark it; and as the circles and diviſions upon the ſurface of the globe itſelf, are not always ſufficiently to be depended on for this purpoſe, I have found the following expedient fully to anſwer. Chuſe any plain white part of the globe's ſurface, anſwerable to the declination given, and with the point of a needle or protracting pin, by the help of the diviſions of the braſs meridian, mark a fine point upon the blank ſurface of the globe, and upon this point make a dot with ink, with the ſmall point of a pen, which rub off with the finger, and it will leave a fine black ſpeck behind. This dot being brought to the meridian, rectify the horary index to it, and it will accurately repreſent the center of the celeſtial body whoſe inveſtigation is wanted.



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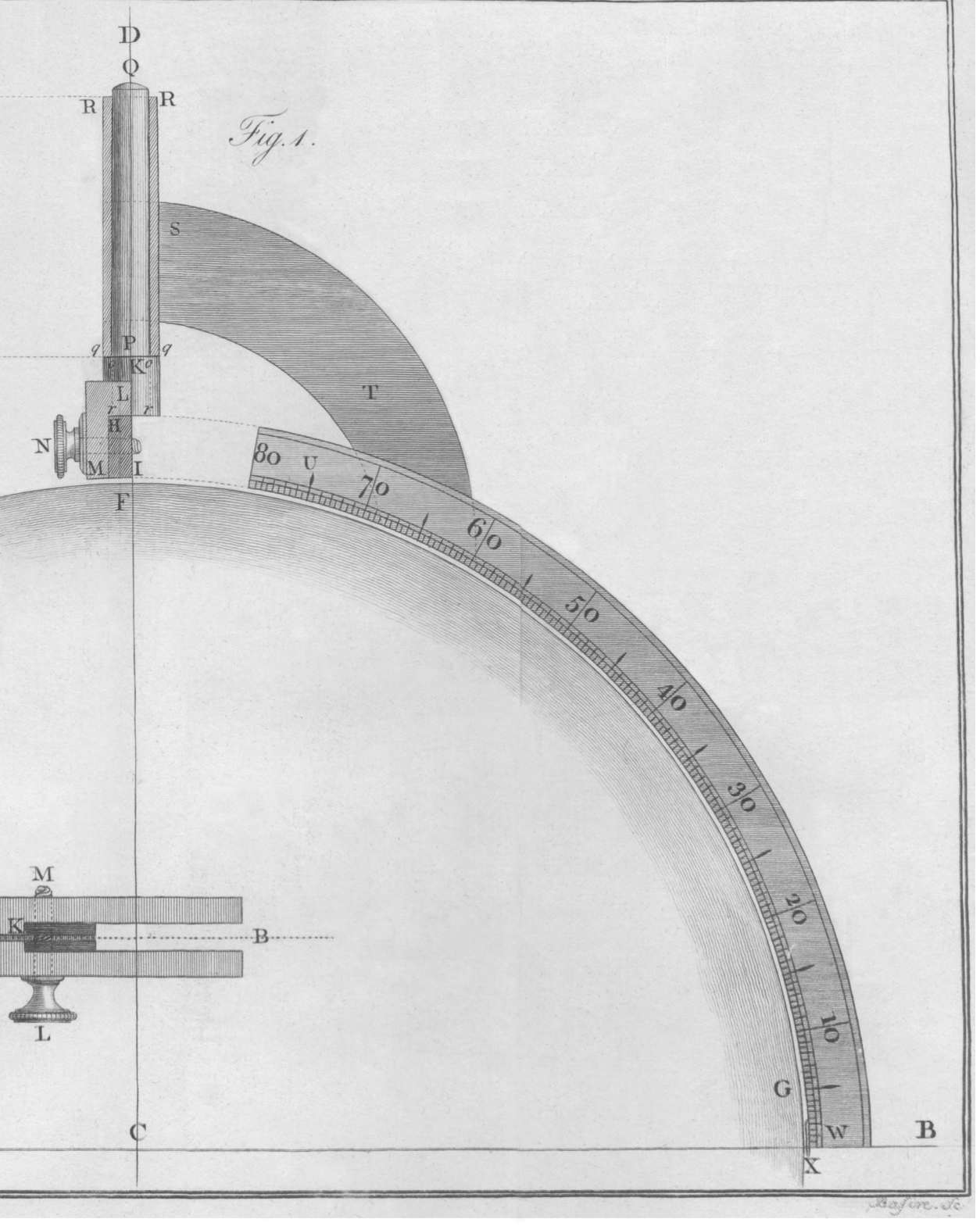

Fig. 1.